The Macroeconomic Consequences of Capital Constraints

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Abstract

This paper quantifies the effect that regulatory capital requirements have on bank lending and real economic activity. Exploiting a change in capital requirements by the Federal Reserve at the onset of the pandemic recession, it establishes causally that looser requirements increased bank credit provision to consumers. On average, banks who received relatively more balance sheet space from the policy change passed this along to their customers in the form of relatively higher credit limits from Q2 2020 to Q1 2021, which also led to relatively higher credit card borrowing among these customers. Using a general equilibrium quantitative model calibrated to match the empirical findings, the paper shows that absent the Federal Reserve policy change, consumption would have fallen by an extra 2.7% in the three years following the pandemic recession. Motivated by these estimates, this paper evaluates the efficacy of countercyclical capital requirements and finds that such policy could lower consumption volatility over the business cycle by as much as 12%.

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1 Introduction

Since the Global Financial Crisis, financial regulators have relied on capital requirements as a tool to maintain financial and macroeconomic stability. Capital requirements can help alleviate downturns by strengthening financial institutions' balance sheets in anticipation of adverse shocks. However, requiring banks to hold more capital can come at the cost of reduced lending to households and firms. While capital requirements have become one of the cornerstones of financial regulation, there is limited direct evidence on their impact on consumer lending, and more broadly, on their contribution to the stabilization of the business cycle.

This paper establishes that looser capital requirements lead to expanded consumer credit and that *countercyclical* constraints can help reduce business cycle volatility. The findings of this study are rooted in a policy change by the Federal Reserve in 2020. In response to the COVID-19 pandemic, the Federal Reserve relaxed capital requirements for banks. Because different banks were differentially affected by this policy, we recover a causal estimate of the effect of relaxing capital requirements on bank lending. We use this estimate in a quantitative general equilibrium model and calculate that, absent the regulatory change, aggregate consumption in the U.S. would have fallen by an extra 2.7% in the three years following the pandemic recession. Additionally, we use the model to show that countercyclical capital requirements can lower consumption volatility over the business cycle by as much as 12%.

We start by considering the changes to the *supplementary leverage ratio* (SLR) rule announced by the Federal Reserve at the onset of the COVID-19 pandemic. The SLR, a pillar of the Basel III regulatory framework that followed the Global Financial crisis, was adopted to strengthen the balance sheets of financial institutions. On April 1, 2020, the Federal Reserve announced changes to how the ratio was computed: it excluded U.S. Treasury securities and deposits at the Federal Reserve from the calculation. The policy led to an unexpected increase in the SLR for banks which, consequently, became less constrained and gained capacity to lend. This setting provides an ideal natural experiment to study the role of bank capital requirements (see Koont and Walz 2021; Favara, Infante and Rezende 2022 for related studies of the SLR rule change).

The paper first establishes empirically the causal effect that relaxing capital requirements has on consumer lending. The policy change did not affect all banks equally: banks with lower initial SLR and banks with more Treasury securities were most affected. We quantify this by constructing a measure of "regulatory slack" that captures the change in each bank's capital buffer as a result of the Federal Reserve policy. The measure we build compares each bank's SLR under the new calculation to the "counterfactual SLR" under the original calculation. The slack measure also accounts for how close a bank originally was to the regulatory threshold.

We first test for effects on aggregate credit card lending at the bank level using data from the Federal Reserve Bank's FR Y-14 reporting form. For each reporting bank, we calculate aggregate credit limits, aggregate balances, total number of accounts, and average annual percentage rate

(APR) across all their credit card accounts each month from one year before to one year after the relaxation of the SLR rule. We find that banks that had more slack as a result of the policy change generally increased their credit limits and trade lines relatively more, while reducing the average APR charged on revolving balances. This also resulted in relatively more borrowing by consumers in terms of credit card balances. However, this type of aggregate analysis does not allow us to isolate the credit supply effects from customer demand-driven selection effects. Therefore, to establish the causal effect of relaxing the SLR rule, we must turn to a different data source that allows for tracking of the same consumer across multiple banks.

To quantify consumer-level effects of the policy change, we turn to a random sample of consumer credit data from *Equifax*. We map each credit card to a unique financial institution and identify within customer-month effects on credit limits and credit card balances. Our empirical setup allows for the identification within customer-month by comparing effects for the same customer holding multiple credit cards serviced by different banks at the same time. This ensures that the effect is not driven by differential access to banks by households that were differently impacted by COVID-19, or by customer characteristics that are only observable to the banks. Using consumers in the Equifax data, we establish that a one standard deviation increase in regulatory slack led to an average 1.5% to 3.5% increase in credit card limits and an associated 5.4% to 13.3% increase in credit card balances. These results are consistent with the findings in Koont and Walz (2021), who, leveraging the same SLR policy change, shows that banks that received more slack expanded lending to firms by more.

It is important to emphasize that the impacts we document are *relative* effects: we show that banks given more slack by the rule change extended *relatively* more credit to their consumers. In other words, these causal estimates miss *general equilibrium* effects. However, such general equilibrium effects are what ultimately matter to policymakers when evaluating the consequences of relaxing capital requirements. To understand the aggregate effects of relaxing capital requirements both following the pandemic recession and more generally under a countercyclical rule, we build a quantitative, general equilibrium model of consumer lending in which banks are subject to capital requirements. This model displays a continuum of "islands," each populated by a representative bank and heterogeneous consumers. Consumers subject to idiosyncratic productivity shocks can save via deposits or borrow from their bank. Bankers lend deposits and hold government debt and are subject to a capital constraint.

The model is calibrated using simulated method of moments to jointly match key moments of the U.S. macroeconomy and, most importantly, the partial equilibrium lending response to a relaxation of capital requirements that we find in the data. That is, we run the same regression in the model as the data and ensure that, when subject to a relaxation in capital requirements, banks expand lending as indicated by our empirical findings. This means that the model calibration takes our causal estimates seriously, granting validity to the general equilibrium implications of relaxing capital requirements.

We use the calibrated model to answer two questions. First, how meaningful was the Federal Reserve policy change during the COVID-19 pandemic? Second, what would business cycle fluctuations look like if we adopted countercyclical capital requirements that tightened in booms and loosened in busts? In the first exercise, we use the model to exactly match U.S. output dynamics following the COVID-19 pandemic. We then run a counterfactual and study macroeconomic activity under the scenario in which the Federal Reserve did not relax capital requirements. Under this scenario, consumption would have fallen by an extra percentage point on impact and by a total of 2.7% over the next three years. This larger decline in consumption is coupled with a bigger fall in lending by banks. Thus, relaxing capital requirements during the pandemic expanded bankers' lending capacity and reduced the severity of the recession.

The second application of the model quantifies the volatility of consumption in a regime with countercyclical capital requirements versus one without. Traditionally, central banks and regulatory agencies have not used capital requirements as a business cycle stabilization tool even though there has been much discussion around this recently (Repullo and Saurina Salas, 2011). To determine the efficacy of countercyclical constraints to stabilize the business cycle, we calibrate an aggregate productivity shock process to match U.S. GDP dynamics from Q1 1948 to Q4 2019. We evaluate the model economy subject to shocks simulated using the estimated productivity process under a benchmark regime where the capital constraint is fixed to the steady state level and a second regime in which the capital constraint covaries with output. For the appropriate covariance consumption volatility with a countercyclical capital constraint rule falls by 12% relative to the benchmark model. In sum, capital requirements can be used as an effective tool to stabilize business cycle fluctuations.

Related Literature. This paper contributes to three main strands of literature: (1) bank capital requirements and lending, (2) consumer credit, and (3) macroeconomic effects of regulatory requirements.

This paper contributes to the literature on bank balance sheet costs and lending. Over the last 50 years, there have been increasingly stringent regulatory requirements on banks in the form of capital requirements, oversight, and fees. Previous research suggests that there has also been a long term secular decline in on-balance sheet lending by banks during this period and that one of the drivers is increased regulatory burden (Buchak et al., 2024*a*,*b*). Regulatory requirements are passed on to consumers in mortgage markets (Benetton, 2021; Demyanyk and Loutskina, 2016) and business lending (Favara, Infante and Rezende, 2022; Bridges et al., 2014), but there has been little evidence of pass-through to consumer credit markets. Consumer credit markets can be a significant source of liquidity for households (Fulford and Schuh, 2024; Greene and Stavins, 2022) and banking theory suggests that banks may be efficient providers of this form of liquidity (Kashyap, Rajan and Stein, 2002; Diamond and Rajan, 2001). Our paper shows that regulatory requirements that increase bank balance sheet costs are passed to consumers via asset side bank liquidity provision. To our knowledge, we are the first to provide direct causal evidence for this channel, and our results suggest the regulations designed to make banks safer do dampen consumer lending.

This paper is also related to the provision of consumer credit, specifically through credit cards, and its broader effects on the economy. We show that a consequence of increased financial regulation on banks is reduced consumer credit, which can have additional downstream effects on impacted households. Recent literature has studied the link between increased consumer credit access and a variety of outcomes, including more volatile business cycles (Mian, Sufi and Verner, 2020; Herkenhoff, 2019), higher inflation (Geanakoplos and Dubey, 2010), greater self-employment (Herkenhoff, Phillips and Cohen-Cole, 2021), and better labor search outcomes (Herkenhoff, Phillips and Cohen-Cole, 2023).

This paper adds to the broader discussion on the direct and indirect impacts of financial regulation, especially in consumer credit markets (Campbell et al., 2011; Posner and Weyl, 2013). To date, the majority of the literature that has focused on consumer credit has studied the direct effects of credit card related regulations such as the 2009 Credit Card Accountability Responsibility and Disclosure (CARD) Act (Agarwal et al., 2015; Jambulapati and Stavins, 2014; Debbaut, Ghent and Kudlyak, 2016). In contrast, our study is unique because the main rationale behind the temporary change in SLR calculation was to ease strains in the Treasury market with a secondary focus on credit provision to businesses and households.[1] This novel setting allows us to quantify the pass-through of wider-ranging regulation on the consumer credit market, bypassing issues such as selection and targeted rulemaking that may arise when studying regulations specific to credit cards.

Much of the literature uses empirical methods to understand the partial equilibrium effects of bank regulatory requirements on lending (Koont and Walz, 2021; Favara, Infante and Rezende, 2022). This paper, while taking the micro estimates seriously, asks what the general equilibrium effects of capital requirements are. Doing so allows us to address questions of growing importance to policymakers that partial equilibrium estimates are not well suited to answer, such as what the effects of countercyclical capital requirements are on business cycle fluctuations (Drehmann et al., 2010; Drehmann and Gambacorta, 2012). In doing so, this paper joins a growing literature in macroeconomics that uses well identified partial equilibrium estimates to understand the macro, general equilibrium effects of policy (Arellano, Bai and Bocola, 2017; Auclert and Mitman, 2018).

The paper is developed as follows. Section 2 gives the background behind the SLR and the Federal Reserve policy, as well as the construction of the slack measures used throughout the paper. Section 3 studies bank-level effects using data from the Federal Reserve Bank's FR Y-14 reporting form. Section 4 analyzes consumer-level effects using Equifax data. Sections 5 and 6 develop and calibrate a general equilibrium model. Sections 7 and 8 use the model to ask how the U.S. economy would have behaved during the pandemic absent the policy change and what countercyclical capital requirements would imply for business cycle volatility. Section 9 concludes.

[1]See Federal Reserve Press Release from April 1, 2020

2 Background on the supplementary leverage ratio

This section presents an account of the supplementary leverage ratio rule implementation and the relevant changes imposed by the Fed at the onset of the COVID-19 pandemic. Additionally, we construct a measure of how much each bank's capital requirements were relaxed as a result of the rule change.

2.1 Timeline.

In the aftermath of the 2007-09 financial crisis, Basel III proposed a minimum supplementary leverage ratio for banks, with the aim of having a more resilient financial sector with more and higher quality capital. The United States implemented a version of this ratio to become compliant with Basel III. As of January 1, 2018, banks with more than $250 billion in assets or at least $10 billion in total on-balance sheet foreign exposures were required to hold Tier 1 capital in excess of 3% of their total leverage exposure. The Federal Reserve tightened this requirement to 5% for systemically important financial institutions (SIFIs). Additionally, these institutions must maintain an SLR of at least 6% to be considered "well capitalized" (Board, 2018). Failure to meet the SLR requirement may lead to regulatory intervention, including restrictions on capital distributions to shareholders and bonus payments to bank employees.

The denominator of the SLR, the total leverage exposure, includes all on-balance sheet exposures, derivative exposures, repo-style transactions, and off-balance sheet exposures.[2] An important feature of the SLR is that all on-balance sheet exposures are treated one for one. This includes treasuries and treasury collateralized repo-style transactions. In contrast, other regulatory ratios, such as the tier 1 capital ratio, gives treasuries very low weight. The result of this is that treasuries impact the SLR relatively more than they do for other regulatory ratios. This makes the SLR more likely to bind than other constraints, especially so for banks with dealer affiliates that are active in treasury and repo markets.

This feature of the SLR became especially important at the start of the COVID-19 pandemic. In March 2020, there was a *dash for cash* that resulted in market participants trying to sell their treasuries to fulfill obligations and build cash reserves (Barone et al., 2023; Duffie, 2020). Eventually, the selling pressure became so high that dealers stopped accepting sell orders due to binding balance sheet constraints. The Federal Reserve tried to ease pressures by purchasing Treasuries. While these purchases helped lower the total selling pressure they did little to directly alleviate dealer balance sheet pressure. By purchasing a Treasury, the Federal Reserve essentially swaps the asset with a bank reserve on the balance sheet of banks, and bank reserves also enter the denominator of the SLR. Bid-ask spreads on Treasuries rose to 20 times their typical level in March

[2] The actual calculation of the SLR involves several deductions and nuances, the details of which are not relevant for our study. For a full explanation of all of the line items refer to pg. 5-6 of the reporting form, found at https://www.ffiec.gov/pdf/FFIEC_forms/FFIEC101_202403_f.pdf

2020, and evidence suggests that this was due to low bank demand for treasuries, in part due to concerns over a binding SLR (Younger, 2020; Seidner and Wilding, 2021).

On April 1, 2020, two weeks into the COVID-19 Pandemic, the Federal Reserve announced a change in its SLR rule (Board, 2020). The change excluded "U.S. Treasury securities and deposits at Federal Reserve Banks from the calculation of the rule for holding companies", and would be in effect until March 31, 2021. This exemption mechanically resulted in a (weakly) higher SLR for banks. The stated purpose of this change was "to ease strains in the Treasury market resulting from the coronavirus and increase banking organizations' ability to provide credit to households and businesses". This policy change by the Federal Reserve serves as a natural experiment to examine how much relaxing capital constraints affects banks' ability to provide credit.

Computing the Supplementary Leverage Ratio. To compute the SLR for each bank over time, we use form FFIEC 101 from the Federal Financial Institutions Examination Council. In these data, banks report several balance sheet components. The SLR for institution b at time t is computed as

$$SLR_t^b = \frac{\text{Tier 1 Capital}_t^b}{\text{Total Leverage Exposure}_t^b} \tag{1}$$

The numerator is bank b's Tier 1 capital.[3] The denominator is the bank's total leverage exposure, the *sum* of (i) total consolidated assets, adjustments for (ii) investments in banking, financial, insurance, and commercial entities consolidated for accounting purposes but outside the scope of regulatory consolidation, (iii) fiduciary assets recognized on-balance sheet but excluded from total leverage exposure, (iv) derivative and (v) repo-style transactions, and (vi) off-balance sheet exposures, *minus* adjustments for (vii) deductions from Tier 1 capital, and (viii) frequency calculations. On April 1st, 2020, the Fed added a new line item to the FFIEC101 form, which allowed for deductions of qualifying central bank deposits for custodial banking organizations. The number given in this line item quantifies the additional balance sheet space that the Federal Reserve's policy gave to banks, and allows us to assess the impact of the policy change.

Form FFIEC 101 identifies financial institutions using a numeric `RSSD ID`. The same institution may have subsidiaries with different `RSSD IDs`, but, because the SLR regulation applies to the parent company, we only compute the SLR for parent company `RSSD IDs`. Using the *NIC National Information Center* by the Federal Financial Institutions Examination Council[4], we map `RSSD ID` to bank name, which will allow us to link FFIEC 101 to other datasets.

Regulatory *slack*. We define the measure of regulatory slack each bank experiences following the Fed policy announcement on April 1, 2020. To do so, we start by constructing a *counterfactual* SLR for each bank at each date t between Q2 2020 and Q1 2021, the period in which the

[3] For details on the components of Tier 1 capital, see `https://www.ffiec.gov/pdf/FFIEC_forms/FFIEC101_202312_f.pdf`
[4] https://www.ffiec.gov/npw

relaxed policy was in place. As per the implemented policy, the *realized* SLR_t^b during this period excludes adjustments for deductions of qualifying central bank deposits for custodial banking organizations (term ix) from the denominator in equation (1). However, because this quantity is still reported in form FFIEC 101, we can compute what the SLR would have been had the regulatory change not occurred. We denote this *counterfactual* measure by $\widehat{SLR}_t^b$. By construction, the true SLR is always at least as large as the counterfactual SLR. Figure 1 shows how, on average, banks experienced an increase in their SLR vis à vis their counterfactual SLR from April 2020 to March 2021. The increase was sizeable, jumping by more than 1% on average across banks. The implication of this policy was that banks were less constrained by the SLR limit.

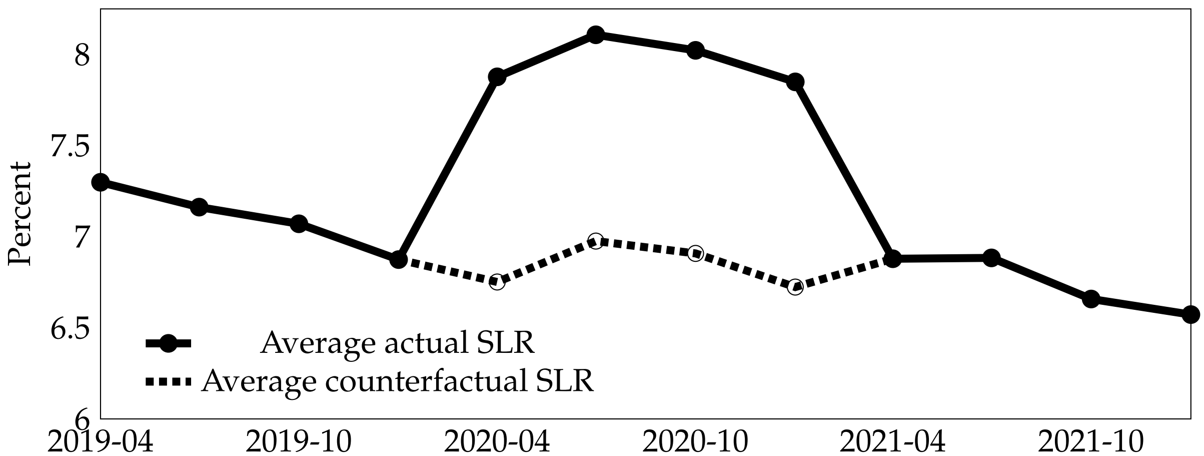


Figure 1: Actual and counterfactual SLR, averaged over banks in our sample. Source: FFIEC 101, Authors' analysis.

The obvious follow-up question is *how much* less constrained were banks? We define our preferred measure of *slack* for bank b at time t, as

$$\text{slack}_t^b = \frac{SLR_t^b - \widehat{SLR}_t^b}{SLR_t^b - 5} \tag{2}$$

The numerator is the change in SLR the bank experiences because of the policy. The denominator accounts for how far the bank actually is from the SLR regulatory limit. This adjustment is made because, for the same change in SLR, banks closer to the constraint should experience more slack.[5]

While equation (2) is our preferred measure of slack, we also consider the more naïve measure that accounts solely for the experienced change in SLR and does not account for how binding the constraint actually is. This alternative measure is

$$\widetilde{\text{slack}}_t^b = SLR_t^b - \widehat{SLR}_t^b \tag{3}$$

[5]While the announcement of the policy change occurred in April, because of the relatively slow adjustment evident in Figure 1, we use the slack measure over the four quarters of the policy.

3 Bank-Level Consumer Credit

Stricter capital requirements can help make the financial system more sound but they come at the cost of restricted lending capacity. This logic suggests that, after the Fed relaxed the SLR rule in April 2020, banks were better able to provide credit than they otherwise would have been had the capital constraint not been relaxed. Looking at the aggregate lending behavior of banks, this is exactly what appears to have happened. As Koont and Walz (2021) and Favara, Infante and Rezende (2022) found, the relaxation of the rule is associated with overall credit expansion. In this paper, we focus on the impact to consumer credit, specifically through credit card lending.

3.1 Data

The data for aggregate bank-level credit card limits and balances comes from the Federal Reserve Bank's FR Y-14M reporting form. For each reporting bank, we find aggregate credit limits, aggregate balances, total number of accounts, and average APR across all of their credit card accounts each month. We study the period from one year before (April 2019) to one year after (March 2021) the relaxation of the SLR rule, and restrict to banks that reported every month over that 24 month period.

Table 1 presents some summary statistics for the 10 banks in our sample over the 24 month period. Aggregate credit card limits and spending decreased in the first year following the onset of the pandemic. In our data, we see that the mean bank saw total credit limits decrease from \$329 billion in the pre-period to \$311 billion in the post-period, and an associated total balance decrease from \$62 billion to \$55 billion. Similarly, the total number of credit card accounts and the average APR charged also fell. Due to the Fed's policy, SLR is on average higher in the post period (8.1%) than the pre-period (7.3%), resulting in an average of 0.44 for our preferred slack measure and an average of 0.96 for the alternative slack measure.

3.2 Bank-Level Results

Banks benefited differently from the SLR relaxation, depending on their starting SLR and their involvement in treasury markets. We can use this exogenous heterogeneity in bank exposure to the change in SLR policy to see how banks pass this constraint on to their customers. Restricting our analysis to credit card lending, the object of this paper, we run the regression in equation (5), where $y_{i,t}$ is either the log of total credit limit, the log of total balances, the log number of trade lines, or the average annual percentage rate (APR) for bank i at time t. $\widehat{SLR_{i,t}}$ is the counterfactual SLR for bank i at time t, and $slack_i$ is the slack of bank i computed in Q2 2020. Additionally, we control for time fixed effects.

$$y_{i,t} = \alpha + \beta \cdot \widehat{SLR}_{i,t} + \gamma \cdot slack_i + \delta \cdot slack_i \times \mathbb{I}\,(\text{policy}) + \zeta_t + \varepsilon_{i,t} \tag{4}$$

	N	mean	median	std. dev.
credit limit (\$*bn*)	240	320.55	176.03	292.00
pre-period	120	329.16	178.02	299.22
post-period	120	311.94	170.23	285.58
balance (\$*bn*)	240	58.12	32.42	51.43
pre-period	120	61.52	34.23	54.39
post-period	120	54.73	31.29	48.28
no. accounts (*mn*)	240	43.75	22.84	44.53
pre-period	120	45.32	22.88	46.41
post-period	120	42.18	21.30	42.71
avg. APR (%)	240	18.45	17.75	2.38
pre-period	120	19.21	18.29	2.28
post-period	120	17.69	17.48	2.22
SLR (%)	240	7.71	7.37	1.36
pre-period	120	7.28	7.22	1.21
post-period	120	8.14	7.53	1.37
$\widehat{SLR}$ (%)	240	7.16	6.98	1.22
pre-period	120	7.28	7.22	1.21
post-period	120	7.03	6.80	1.22
$slack$ (Q2 2020)	10	0.44	0.95	1.11
$\widetilde{slack}$ (Q2 2020)	10	0.96	0.99	0.32

Table 1: Summary statistics for the 10 banks during the 24 month sample of interest. Sources: FFIEC 101, Federal Reserve Y-14M, Authors' analysis.

The results of this analysis are shown in Table 2 for both the benchmark and the alternative measure of slack. Depending on the measure, a one standard deviation increase in slack in the months the policy was implemented is associated with a 1.8 to 4.5% higher increase in credit limits, a 3.3 to 5.2% higher increase in total balances, a 3.2 to 3.3% higher increase in total number of trade lines, and a 5 to 16 basis points larger drop in average APR.[6]

While the majority of these results do not reach the standard level of statistical significance, they are suggestive of sizeable credit expansion and loosening lending standards. In addition, they do not credibly establish the *causal* effect of relaxing the SLR on banks' credit provision because effects may be clouded by selection of different types of consumers into these banks. In the next section, we introduce microdata and an empirical strategy that allows us to bypass this issue and causally quantify the effect.

[6] All numbers are calculated by multiplying the average $slack$ and $\widetilde{slack}$ by the point estimates on the interaction term in their respective columns. Lower and upper bounds correspond to the coefficients on the two different measures of slack.

	credit limit		balances		no. accounts		avg. APR	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\widehat{SLR}$	-0.524	0.129	-0.504	0.187	-0.308	0.267	0.851	0.602
	(0.433)	(0.403)	(0.460)	(0.413)	(0.490)	(0.422)	(0.739)	(0.620)
$slack_i$	-1.082**		-1.135**		-0.952**		0.479	
	(0.352)		(0.361)		(0.387)		(0.463)	
$slack_i \times \mathbb{I}(\text{policy})$	0.041		0.047		0.029		-0.042	
	(0.037)		(0.042)		(0.045)		(0.110)	
$\widetilde{slack_i}$		-1.769*		-2.046*		-1.537***		0.093
		(0.939)		(0.991)		(1.015)		(1.363)
$\widetilde{slack_i} \times \mathbb{I}(\text{policy})$		0.055		0.103		0.101		-0.501**
		(0.050)		(0.062)		(0.097)		(0.173)
date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	240	240	240	240	240	240	240	240
R^2	0.387	0.143	0.391	0.176	0.298	0.121	0.231	0.208
Within-R^2	0.387	0.142	0.390	0.174	0.298	0.121	0.132	0.106

Table 2: Effect of looser SLR on aggregate, bank-level credit limits, balances, number of accounts, and average APR. Standard errors are clustered by bank and month. Sources: FFIEC 101, Federal Reserve Y-14M, Authors' analysis.

4 Consumer-Level Effects

4.1 Data

Consumers' credit card limits and balances are derived from a representative sample of U.S. individuals provided by Equifax. Selected individuals are assigned a unique consumer ID and remain in the panel for the entire period. We are specifically interested in credit limits and balances on credit cards for each consumer. Importantly, the dataset provides information on the financial institution servicing each card, which is necessary as we are interested in the supplementary leverage ratio of the institution.[7] Each month, we aggregate credit limits and balances for all credit cards that a single consumer has with each bank to get a total credit limit and balance for each unique bank-consumer relationship. To test for heterogeneous impacts across consumer characteristics, we also record each individual's income, vantage score, and age.

Table 3 Panel A presents summary statistics for our main dataset of interest. There are a total of 593 million consumer-bank-month observations for the 24 months between April 2019 and March 2021. The median consumer is between 45-54 years old with an income of $41,000. They carry a total credit card balance of $432 with a total credit limit of $7,587 for each bank through which they hold at least one credit card. The average consumer holds a credit card at around 1.70 banks each month and holds an average of 1.27 credit cards per bank.

The rest of Table 3 show average credit card statistics split by consumer characteristics. Panel B

[7]We use two *Equifax* tables. The *equifax_analytic* table provides an unintelligible string that, through the *servicer_mapping* table, can be mapped into the servicer institution name.

shows averages split by income. The majority of consumers are in the \$25,000-\$49,000 or \$50,000-\$99,000 bins, and both credit card balances and limits tend to increase with income. Panel C shows splits by vantage score. The majority of consumers are considered to have excellent vantage scores. While mean credit limits increase with vantage score, consumers with higher vantage scores tend to hold smaller balances. Finally, Panel D splits the sample by age bin. For every bin above the lowest age bin, credit card limits are relatively stable. Balances are highest among those in the middle age bins (35-44 years old and 45-54 years old) and lower for the youngest and oldest consumers.

Because individuals in the Equifax dataset are identified at the consumer-level even across banking institutions, it allows for tracking of a single consumer across the multiple credit cards they have active across different banks, which is not possible for the FR Y-14 dataset. This is critical for our identification strategy in this section as we are able to identify within-consumer-month effects of the rule change.

4.2 Within-Consumer Results

This section quantifies the impact that relaxing the SLR constraint had on banks' willingness to lend to consumers. We leverage the fact that different banks were differentially affected by the policy: for some institutions the policy was inconsequential, others experienced an increase in SLR but were well-capitalized to begin with, and others still were close to the binding constraint and got meaningful relief from the SLR increase.

$$y_{c,i,t} = \alpha + \beta \cdot \widehat{SLR}_{i,t} + \gamma \cdot slack_i + \eta \cdot \mathbb{I}\,(\text{policy}) + \delta \cdot slack_i \times \mathbb{I}\,(\text{policy}) + \zeta_t \times \zeta_c + \varepsilon_{c,i,t} \qquad (5)$$

We interpret the coefficient of interest, δ, as the effect of an additional unit of slack on the outcome y, either credit limits or balances, in the period after the Fed policy took effect. We run three specifications with increasing levels of fixed effects. The most stringent specification includes consumer by month fixed effects, so that the relevant variation comes from different trade lines under the same consumer. Doing so relaxes concerns of changes in credit *demand* rather than credit *supply*. If, for example, consumers with higher credit demand selected into banks who happened to get more slack, we would see their credit limits (and balances) increase on all their cards, not just on those serviced by the banks that experienced more slack.

The coefficients resulting from these regressions are shown in Table 4. In general, the coefficient of interest on the interaction is positive and significant using either measure of slack and for both credit limits and balances. This indicates that increased slack induced banks to extend additional credit to their consumers, which in turn led to relatively higher credit card borrowing among these consumers. Focusing on columns (5) and (6) where the specification includes consumer by time

Panel A: Full Sample

	N	10%	25%	50%	75%	90%	mean	std. dev.
credit limit ($)	593M	1,000	2,900	7,587	15,000	25,150	11,160	47,847
balance ($)	593M	0	0	432	2,362	6,117	2,113	4,273
utilization (%)	593M	0.0	0.0	6.1	59.5	90.8	27.5	101.0
vantage score	593M	591	668	756	807	823	725	112
income ($1000)	593M	20	30	41	53	74	45	22
age	593M	25-34	25-34	45-54	55-64	65-74	45-54	n/a
$slack$	593M	0.23	0.31	0.47	1.36	1.53	0.82	0.58
$\widetilde{slack}$	593M	0.65	0.73	0.88	0.97	1.11	0.89	0.17
$\widehat{SLR}$	593M	5.75	6.03	6.41	8.87	9.69	7.17	1.50
cards per consumer-bank	593M	1	1	1	1	2	1.27	0.59
banks per consumer-date	350M	1	1	1	2	3	1.70	0.95

Panel B: Split by Income Bin

	≤24k	25-49k	50-99k	≥100k
N	93M	315M	168M	18M
mean credit limit ($)	4,130	9,251	17,016	26,779
mean balance ($)	1,276	2,041	2,592	3,270

Panel C: Split by Vantage Score Bin

	Poor 300-599	Fair 600-660	Good 661-715	Very Good 716-747	Excellent 748-850
N	61M	71M	78M	63M	315M
mean credit limit ($)	3,766	6,285	8,227	9,931	14,695
mean balance ($)	3,024	3,930	3,506	2,529	1,109

Panel D: Split by Age Bin

	18-24	25-34	35-44	45-54	55-64	65-74	75+
N	53M	107M	111M	121M	106M	64M	29M
mean credit limit ($)	5,408	9,365	11,384	12,390	12,960	13,016	11,853
mean balance ($)	1,417	2,165	2,651	2,438	2,013	1,619	1,271

Table 3: Summary statistics for credit card accounts in Equifax. Panel A presents statistics for the full sample of consumer credit card lines aggregated such that each consumer-bank pair appears once per month. Panels B, C, and D show statistics split by consumer income, vantage score, and age, respectively. Sources: FFIEC 101, Equifax Analytic Dataset, Authors' analysis.

fixed effects, we find that a one standard deviation increase in our preferred slack measure leads to credit limits and balances that are 3.5% and 13.3% higher in the post-period, respectively. Using the secondary measure of slack, a one standard deviation increase in slack is related to increases in credit limits and balances that are 1.5% and 5.4% higher, respectively. While changes in credit limits are similar in magnitude to what was found in the bank-level results in Section 3.2, changes in balances are somewhat higher. This may be due to credit limit and balance increases being more concentrated among groups with generally higher limits but lower balances, such as high vantage score and older consumers (see Table 3 and Section 4.3). Therefore, balance changes may be higher in percentage terms but not necessarily in dollar terms.

Difference in difference. We complement this analysis with a difference in difference approach to estimating the causal impact of slack on credit expansion. We run the following difference in difference regression model.

$$y_{c,i,t} = \widehat{SLR}_{i,t} + \sum_{\substack{h=04/2019 \\ h\neq 03/2020}}^{03/2021} \beta_h \mathbb{1}\left(t = h\right) slack_i + \zeta_t \times \zeta_{c(i)} + \varepsilon_{c,i,t} \tag{6}$$

We interpret the coefficient of interest, β_h, as the causal effect of an additional unit of slack on the outcome y in month h around the policy change. We control for consumer by time fixed effects, $\zeta_t \times \zeta_{c(i)}$. As in the previous analysis, the addition of time by consumer fixed effects implies that the relevant variation comes from different trade lines under the same consumer. Doing so relaxes concerns of changes in credit *demand* rather than credit *supply*. The coefficients resulting from this difference in differences specification are shown in Figures 2 and 3. According to these estimates, a one standard deviation increase in our preferred slack measure leads to increases in credit limit and balances by 5.0% and 18.6% at their peak, respectively. Both the credit limit and balance results fulfill the parallel trends assumption, giving confidence in the causal interpretation of the results.

4.3 Effect of policy on different consumers

Next, we study cross-sectional differences in the effect of this policy across consumers with different income, vantage score, and age. To test for heterogeneous effects, we run regression (6) separately for each group. The results are shown in Figure 4. Credit limit increases were generally higher among consumers with higher income, vantage score, and age. Usage of the newly extended credit limits, as shown by the impacts on balances, were more flat across the income, vantage score, and age spectrums.

	Credit Limit	Balance	Credit Limit	Balance	Credit Limit	Balance
	(1)	(2)	(3)	(4)	(5)	(6)
$slack_i \times \mathbb{I}(\text{policy})$	0.06***	0.30***	0.01	0.12***	0.06***	0.23***
	(0.02)	(0.04)	(0.01)	(0.02)	(0.01)	(0.03)
$slack_i$	-0.13***	-0.28***	-0.15***	-0.17***	-0.18***	-0.23***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.03)
$\mathbb{I}(\text{policy})$	-0.08**	-0.31***				
	(0.03)	(0.03)				
$\widehat{SLR}_{i,t}$	-0.26***	0.05***	-0.09***	-0.15***	-0.10***	-0.17***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
Constant	10.74***	4.66***				
	(0.05)	(0.06)				
Consumer FE			✓	✓		
Month FE			✓	✓		
Consumer × Month FE					✓	✓
N	593,812,033	593,812,033	593,812,033	593,812,033	593,812,033	593,812,033
R^2	0.081	0.002	0.752	0.484	0.785	0.641
Within-R^2	0.081	0.002	0.011	0.002	0.013	0.005

	Credit Limit	Balance	Credit Limit	Balance	Credit Limit	Balance
	(1)	(2)	(3)	(4)	(5)	(6)
$\widetilde{slack}_i \times \mathbb{I}(\text{policy})$	0.05*	0.34***	0.03***	0.19***	0.09***	0.32***
	(0.03)	(0.07)	(0.01)	(0.06)	(0.01)	(0.07)
$\widetilde{slack}_i$	0.06***	0.04	-0.07***	0.18***	-0.10***	0.12***
	(0.02)	(0.03)	(0.00)	(0.04)	(0.01)	(0.04)
$\mathbb{I}(\text{policy})$	-0.06	-0.35***				
	(0.04)	(0.05)				
$\widehat{SLR}_{i,t}$	-0.23***	0.09***	-0.05***	-0.11***	-0.05***	-0.13***
	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.01)
Constant	10.33***	4.10***				
	(0.04)	(0.11)				
Consumer FE			✓	✓		
Month FE			✓	✓		
Consumer × Month FE					✓	✓
N	593,812,033	593,812,033	593,812,033	593,812,033	593,812,033	593,812,033
R^2	0.079	0.002	0.751	0.484	0.783	0.641
Within-R^2	0.079	0.002	0.007	0.002	0.008	0.004

Table 4: Effect of *slack* on credit limits and balances. The top panel uses the preferred definition of slack; the bottom panel uses the naïve definition. Standard errors are double-clustered by consumer and month. Sources: FFIEC 101, Equifax Analytic Dataset, Authors' analysis.

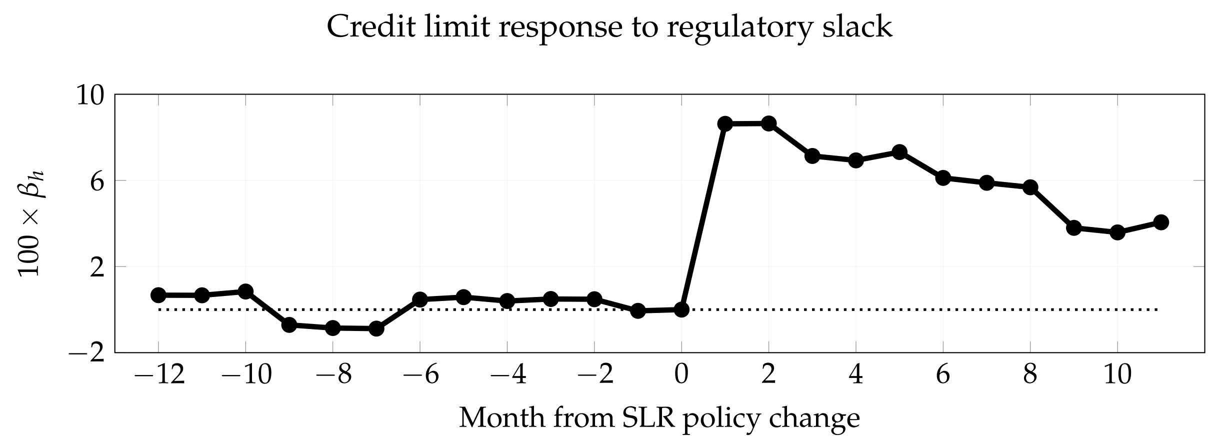


Figure 2: Effect of policy on credit limit using slack and consumer by month fixed effects. All estimates are relative to Q2 2020. Sources: FFIEC 101, Equifax Analytic Dataset, Authors' analysis.

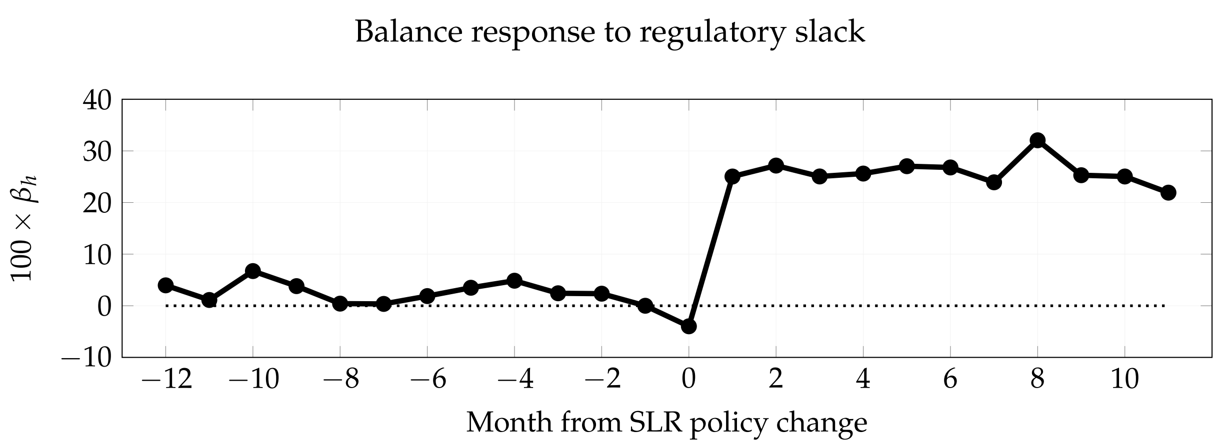
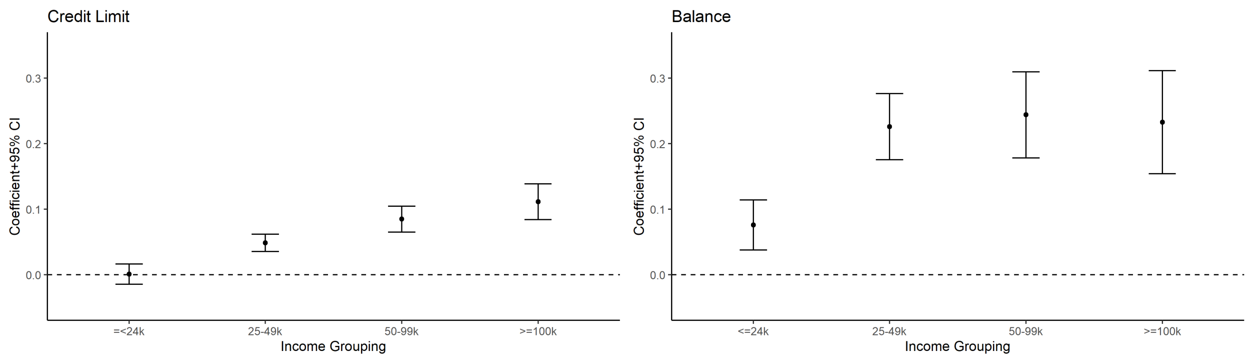
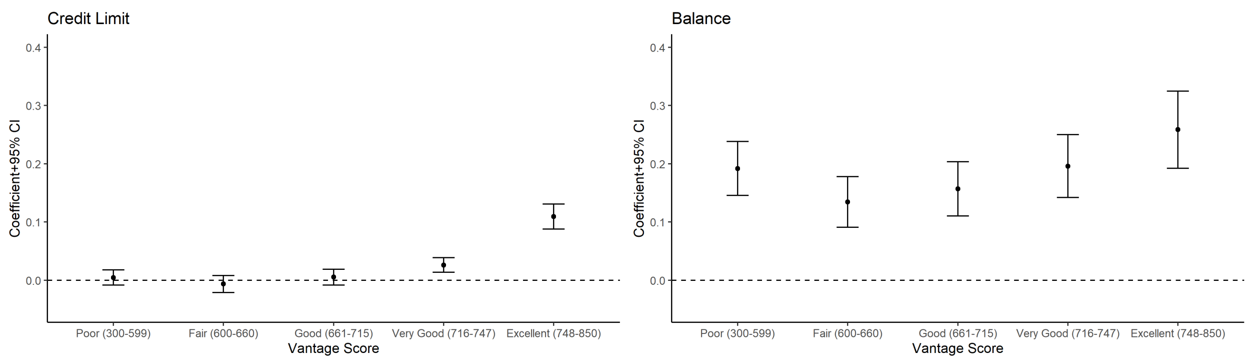


Figure 3: Effect of policy on balances using slack and consumer by month fixed effects. All estimates are relative to Q2 2020. Sources: FFIEC 101, Equifax Analytic Dataset, Authors' analysis.

(a) Income



(b) Vantage Score



(c) Age

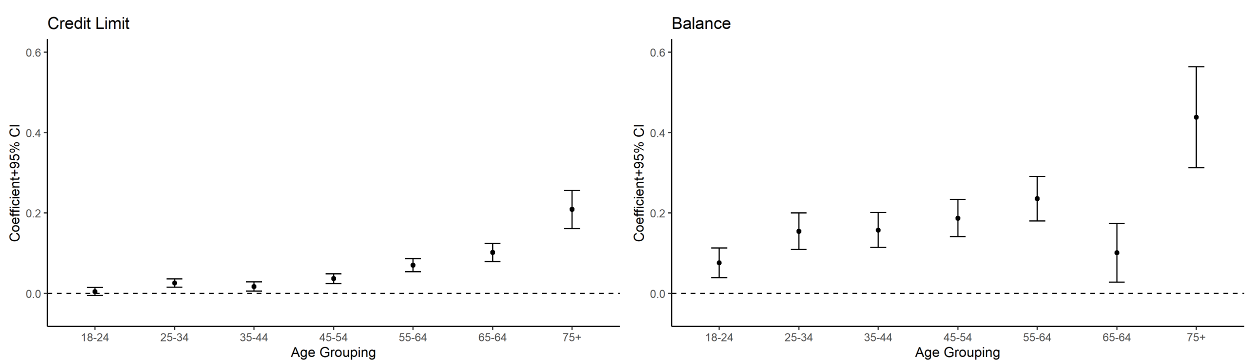


Figure 4: SLR slack effect for different groups of consumers, split by income, vantage score, or age. Sources: FFIEC 101, Equifax Analytic Dataset, Authors' analysis.

5 A macroeconomic model of bank lending

To understand the macroeconomic impact of capital constraints, we cannot rely on the *partial* equilibrium estimates from the previous section, but we develop a *general* equilibrium model of consumer lending in which banks are subject to capital constraints. In this model we are primarily concerned with banks' incentives to lend to household. Therefore, for simplicity, we abstract from certain potential benefits of capital constraints because there is no effective risk of bank runs or failures that capital constraints would mitigate. Future research should evaluate how our results generalize in this richer environment.

There are four types of agents in this economy: consumers, bankers, a representative firm, and a government. The economy is made up of a continuum of islands. On island, j, there is a unit mass of consumers attached to the (representative) bank of the island. While banking is localized, the labor market and the asset market are centralized.

5.1 Consumers

There is a unit mass of heterogeneous consumers indexed by i on island j. Their objective is to maximize the present discounted value of flow utility $u(\cdot)$

$$\mathbb{E}\left[\sum_{t=0}^{\infty}\beta^t u\left(c_{i,t}^j\right)\right]$$

All consumers supply one unit of labor. However, workers differ in their idiosyncratic productivity $z_{i,t}^j$, which coincides with the *efficiency units* of labor they supply. Idiosyncratic productivity follows an AR(1) in logs

$$\log\left(z_{i,t}^j\right) \quad = \quad \rho_z \log\left(z_{i,t-1}^j\right) + \varepsilon_{i,t}^j$$

Consumers earn wage w_t per efficiency unit of labor supplied. They can save or borrow from banks on their island. Saving occurs at interest rate r_t^S, and borrowing occurs at rate r_t^B. Consumers can borrow up to the same island-wide limit $\underline{a}_t^j$, which, along with economy-wide wage w_t and the island-wide saving and borrowing rates are taken as given. The problem they solve is

$$\begin{aligned} V\left(a_{t-1}, z_t\right) \quad &= \quad \max_{c_t,\, a_t} u\left(c_t\right) + \beta\mathbb{E}\left[V\left(a_t, z_{t+1}\right)\right] \\ \text{s.t.} \quad & \quad c_t + a_t = (1+r_t^B)a_{t-1}\mathbb{I}(a_{t-1}<0) + (1+r_t^S)a_{t-1}\mathbb{I}(a_{t-1}\geq 0) + (1-\tau_t)w_t z_t \\ \text{and} \quad & \quad a_t \geq \underline{a}_t^j \end{aligned} \tag{7}$$

5.2 Government

The government issues one period risk-free bonds T_t that pay interest r_t and consumes G_t. To pay for these, the government adjusts the income tax rate τ_t to ensure that each period its budget constraint holds

$$(1+r_t)T_{t-1}+G_t \quad = \quad T_t+\tau_t w_t \tag{8}$$

where total tax revenue is $\tau_t w_t$ because, in each island, idiosyncratic productivity averages to 1.

5.3 Firms

There is a centralized continuum of competitive firms that hire labor from workers from all islands. Firms produce identical goods that are used by households to consume. Because firms are identical, we refer to the representative firm hereafter. Its production function is

$$Y_t \quad = \quad Z_t N_t^{\alpha} \tag{9}$$

where N_t is aggregate labor demand, α is the labor share, and Z_t is aggregate productivity.

5.4 Bankers

Each island j, has a continuum of identical bankers and therefore we refer to banker j as the representative banker on island j. Banker j discounts the future with β, takes in deposits $S^j = \int_{i|a_i^j \geq 0} a_i^j \, di$ from the islands' savers, purchases government bonds, T^j, and lends $B^j = -\int_{i|a_i^j<0} a_i^j$ (defined with the negative sign so it is a positive number) to the islands' borrowers. It pays depositors interest r^S and charges borrowers interest r^B. Banker j is subject to *liquidity shocks* λ^j that are independent and identically distributed across islands.[8] These shocks are unexpected credits from (+) or payments to (-) other bankers that must be fulfilled contemporaneously. Liquidity shocks are the reason why there are capital constraints: bankers must have enough capital to fulfill its obligations even in case they are hit by a bad liquidity shock. Bankers can lend up to share ζ of their total assets. Following Iacoviello (2015), banker j maximizes the utility flow deriving from the stream of dividends

$$\max_{B_t^j, S_t^j, T_t^j} \sum_{t=0}^{\infty} \beta^t u\left(div_t^j\right) \tag{10}$$

$$\text{s.t.} \qquad div_t^j + (1+r_t^S)S_{t-1}^j + B_t^j + T_t^j + \lambda_t^j = S_t^j + (1+r_t^B)B_{t-1}^j + (1+r_t)T_{t-1}^j$$

[8] This version of the model sets $\lambda_t^j = 0$. Non-trivial liquidity shocks (i.e. different from 0) would lead to occasional bank failures and provide an endogenous motivation for capital constraints.

The banker's capital constraint, according to which they must hold enough capital relative to their total assets, is

$$\frac{B_t^j + T_t^j - S_t^j}{B_t^j + T_t^j} \geq \zeta \iff S_t^j \leq (1-\zeta)(B_t^j + T_t^j) \tag{11}$$

Substituting the binding constraint into the maximization problem we get that dividends are

$$\begin{aligned} div_t &= -\zeta\left(B_t^j + T_t^j\right) + (1+r_t^B)B_{t-1}^j + (1+r_t)T_{t-1}^j - (1+r_t^S)(1-\zeta)\left(B_{t-1}^j + T_{t-1}^j\right) \\ &\quad \text{imposing the equilibrium condition } r^B = r \\ &= \left(B_{t-1}^j + T_{t-1}^j\right)\left[(1+r_t^B) - (1+r_t^S)(1-\zeta)\right] - \zeta\left(B_t^j + T_t^j\right) \end{aligned} \tag{12}$$

and the FOC for B (and equivalently for T) is

$$\zeta u'(div_t) = [1 + r_{t+1}^B - (1+r_{t+1}^S)(1-\zeta)]u'(div_{t+1})\beta^B$$

which, when rearranged, leads to the relationship between borrowing and savings rates

$$r_{t+1}^S = \frac{1}{1-\zeta}\left(r_{t+1}^B + \zeta - \frac{\zeta}{\beta^B}\frac{u'(div_t)}{u'(div_{t+1})}\right) \tag{13}$$

5.5 Equilibrium and DAG

The competitive equilibrium is defined as a set of island-specific allocations $\left\{c_{i,t}^j, a_{i,t}^j, B_t^j, S_t^j\right\}$ and prices $\left\{r_t^{B,j}, r_t^{S,j}\right\}$, as well as a set of economy-wide quantities $\{Y_t, N_t\}$, and prices $\{w_t\}$ such that:

1. workers, and bankers optimize on each island,
2. the representative firm maximizes profits, and
3. the asset market clears, $S_t = (B_t + T_t)(1-\zeta)$.

The model can be represented using a directed acyclic graph (DAG), which we use to solve the model along the transition path following perturbations from steady state via the sequence space Jacobian method (Auclert et al., 2021). The DAG representation is shown in figure 5.

6 Calibration

We calibrate the model to match key aspects of the U.S. economy – specifically, the observed response in credit card balances of consumers following the Fed's SLR exemption.

Consider a symmetric steady state where all islands are identical and hence all consumers face the same borrowing limit $\underline{a}^j = \underline{a}$. The utility function is the standard CRRA utility $u(c) = \frac{c^{1-\gamma}}{1-\gamma}$ with

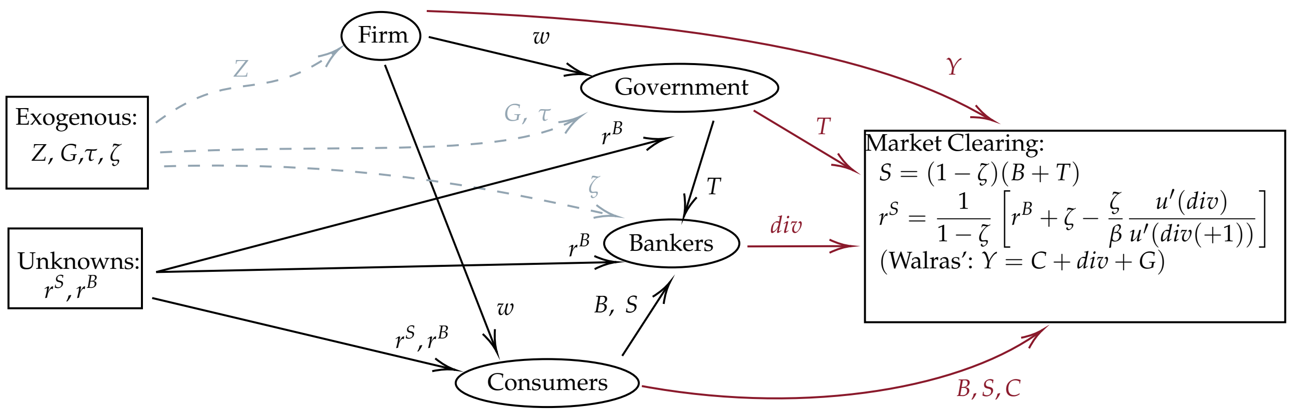


Figure 5: Model DAG. Source: Authors' creation.

risk aversion parameter $\gamma = 2$. Steady state aggregate productivity is normalized to $Z = 1$, and production is constant returns to scale, $\alpha = 1$. These last two parameters, along with the fact that labor productivity averages to 1 across the idiosyncratic shocks to consumers, pins output $Y = 1$ in steady state. We fix steady state government consumption to be 20% of output, $G = 0.2$, and total treasuries to be $T = 1$ so that public debt to output is 100%. We estimate four parameters: the discount factor of consumers, β,[9] the standard deviation of the idiosyncratic productivity process, σ_z, the consumer borrowing limit, $\underline{a}$, and the regulatory capital constraint, ζ. These parameters are estimated to target the following:

1. The average quarterly interest rate paid by U.S. households at the end of 2019. This is computed as $(1 + r^B_{\text{annual}})^{1/4} - 1$ where r^B_{annual} is the sum of mortgage and consumer credit interest paid divded by the sum of mortgage and consumer credit outstanding.[10] The quarterly rate that is derived is $r^B = 0.010064$.

2. Total household debt to GDP in 2019 that stands at 0.64.[11]

3. Total household net worth to GDP in 2019 that stands at 5.03.[12]

4. The elasticity of balances to SLR slack which we estimated to be 0.0164. This is the product of the 0.06 credit limit increase estimated in the previous section and the average utilization rate of 27%. The credit limit estimate on its own would be an overstatement of the lending effect since much of consumers' credit lines are not utilized. To address this we would ideally multiply the estimate by the marginal utilization rate, however, because this is unknown to us, we use the average utilization rate instead. To estimate this, we use the steady state

[9] Note that we impose that this is the same as the discount factor of bankers.

[10] Mortgages outstanding and interest paid are taken from the Bureau of Economic Analysis (2019), consumer credit outstanding and the interest paid are taken from U.S. Bureau of Economic Analysis (2025) and Board of Governors of the Federal Reserve System (US).

[11] Household debt includes housing and non-housing debt and is taken from Survey of Consumer Expectations, FRBNY (2019).

[12] Household net worth is taken from Board of Governors of the Federal Reserve System (US).

policy functions and, keeping the savings rate r^S fixed, relax the capital constraint ζ for one of the islands. The percent change in total debt B_t on that islands is what we target to our estimate.

The model and data values for the targets are shown in table 6.

	Parameter (quarterly frequency)	Value
β	Household discount factor	0.9819
γ	Inverse EIS	2
Z	Aggregate productivity	1
α	Returns to scale	1
G	Government consumption	0.2
T	Government debt	1
σ_{idio}	Standard deviation of idio. shocks	0.291
ρ_{idio}	Persistence of idio. shocks	0.9
$\underline{a}$	Borrowing limit	-2.901
ζ	Regulatory capital constraint	0.05682

Table 5: Model parameters and baseline calibration. Source: Authors' analysis.

Variable	Model	Data
Debt to GDP ($\frac{B}{Y}$)	0.6221	0.6461
Net worth to GDP ($\frac{S+T-B}{Y}$)	1.9075	5.0306
Average borrowing rate (r^B)	0.01108	0.01006
PE elasticity	0.0164	0.017

Table 6: Model and data targets. Sources: Bureau of Economic Analysis, St. Louis Federal Reserve FRED, Survey of Consumer Expectations, Authors' analysis.

7 Relaxing capital constraints during the pandemic recession

One of the Federal Reserve's stated goals for relaxing the SLR requirement during the Pandemic, was to "increase banking organizations' ability to provide credit to households and businesses." In this section we find that, absent the capital constraints relaxation, consumption would have fallen further by almost 1%.

The pandemic recession resulted in a large contraction in output that quickly reverted. While there are many peculiar aspects to the pandemic shock, we follow Fornaro and Wolf (2020) and characterize it as a negative shock to productivity, Z. We estimate a series of productivity shocks Z_t starting in 2020, such that the model, subject to this productivity shock and the relaxation in SLR mimics the fall in output actually experienced during the pandemic recession in the United States. Figure 6 shows the shocks (panel a) and the output response (panel b). The actual shock in the capital constraint consists of a 12-month decrease in the capital requirement, mimicking the Fed relaxation of the SLR constraint. The model allows us to determine the behavior of the economy under the counterfactual in which the Fed had not relaxed capital requirements. Figure 7

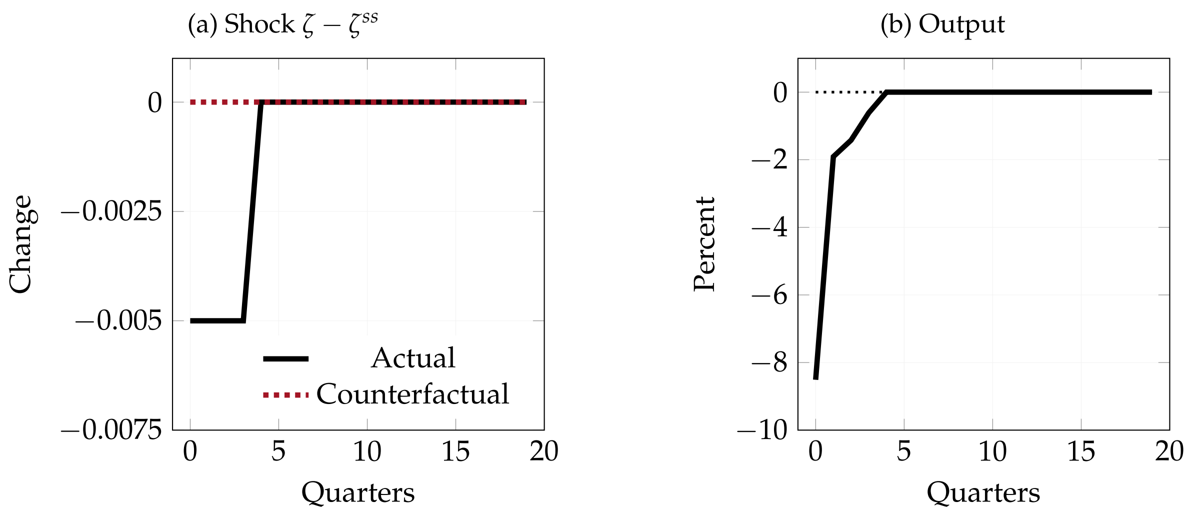


Figure 6: Regulatory shock in panel (a) in both an economy in which the constraint is relaxed (solid black) and on in which it is unchanged (dotted red) and output in panel (b) during the pandemic recession. Sources: Bureau of Economic Analysis, Authors' analysis.

shows aggregate consumption and lending in response to the productivity shock under the actual scenario in which the Fed relaxed capital requirements (solid red) and under the counterfactual scenario in which no relaxation took place. Consumption would have fallen by an extra 1% on impact and would not have recovered for several more months had capital requirements not been loosened. Over the duration of the recession, the cumulative consumption fall would have been 2.7% deeper without looser capital requirements. The channel through which this consumption fall was dampened is the lending channel. Bankers, subject to looser capital constraints, expanded lending compared to the counterfactual scenario. This allowed households to borrow more at the start of the crisis but also to do intertemporal adjustments leading to higher and smoother consumption throughout the recession.

8 Countercyclical capital requirements

Relaxing capital constraints improved credit conditions and macroeconomic outcomes in the aftermath of the pandemic. How would adopting countercyclical capital constraints that are relaxed when output falls and tightened when output booms affect business cycle fluctuations? In this section we find that countercyclical capital constraints decrease consumption volatility by as much as 12%.

Let productivity follow an AR(1) as in equation 14 where $\varepsilon_t^Z \sim \mathcal{N}(0, \sigma_Z)$.

$$\log(Z_t) = \rho_Z \log(Z_t) + \varepsilon_t^Z \tag{14}$$

Next, we calibrated the standard deviation, σ_Z, and the persistence, ρ_Z, of the surprises to match

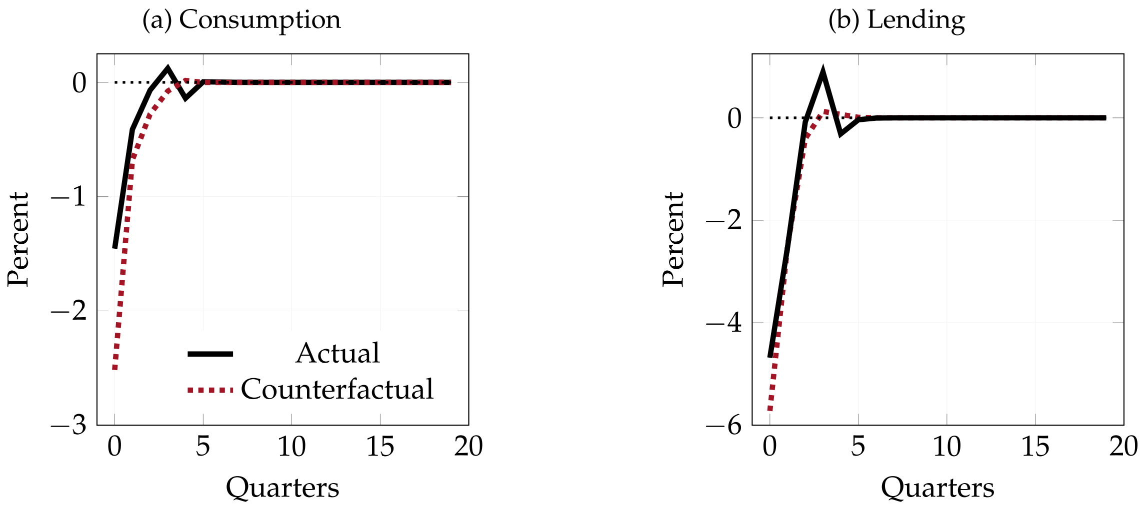


Figure 7: Consumption in panel (a) and lending in panel (b) in an economy in which capital requirements are relaxed (solid black) and in a counterfactual economy in which the capital requirement was not relaxed (dotted red). Source: Authors' analysis.

the standard deviation and persistence of the cyclical component of GDP from Q1 1947 to Q4 2019.[13] Once we have calibrated the productivity process which we subject the model economy to, we compare two scenarios. The first in which the capital constraint is fixed at its steady state level, $\zeta = 0.05$, the second, in which the capital constraint varies with the business cycle according to the expression in 15, for different values of ς. We consider positive values for ς so that, as productivity falls, the capital constraint becomes looser and vice versa.

$$\zeta_t - \zeta^{ss} = \varsigma \left(Z_t - Z^{ss} \right) \times \mathbb{I} \left(Z_t < Z^{ss} \right) \tag{15}$$

Simulating the economy subject to this productivity shock, we compute the cyclicality of consumption under the different regimes. Figure 8 shows the benchmark model, with no countercyclical capital constraint policy, in the black dotted line, and the model with countercyclical capital constraints for different values of ς. For $\varsigma = 0.44$, that is for every 1% fall in productivity the capital constraint loosens by 0.44%, we get that consumption volatility over the business cycle falls by 12%.

9 Conclusion

This paper evaluates how regulatory constraints affect banks' ability to lend to consumers. We exploit a natural experiment from April 2020 in which the Fed unexpectedly announced a relaxation of the supplementary leverage ratio, a key capital ratio in prudential policy. We show that banks that benefited most from the policy change provided relatively more credit to house-

[13] The cyclical component refers to the application of the HP filter to the real GDP time series.

Consumption volatility

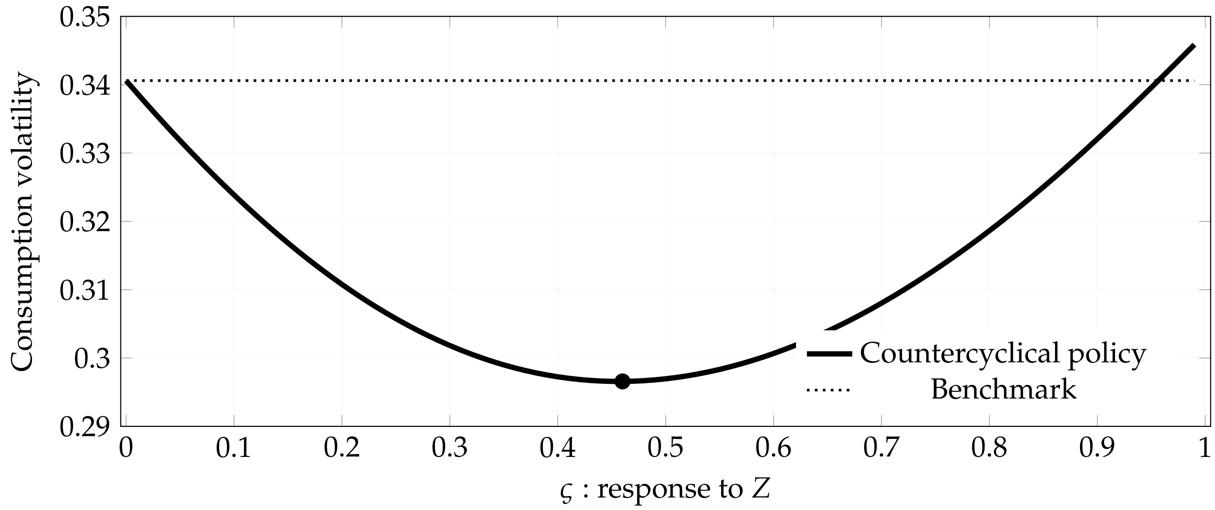


Figure 8: Standard deviation of consumption in the benchmark model with no countercyclical capital constraint (dotted line) and for economies with varying cyclicality (blue line). Source: Authors' analysis.

holds. This partial equilibrium estimate is then used in a general equilibrium macro model to establish two facts. First, had the Federal Reserve not relaxed capital requirements in April 2020, U.S. aggregate consumption would have fallen by an extra 1% on impact and by an extra 2.7% cumulatively over the three years following the COVID-19 pandemic. Second, adoption of countercyclical capital requirements may reduce consumption volatility over the business cycle by as much as 12%.

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A Empirical appendix

We run several variants of to show that the results we find of expanded credit provision are robust. Figures 9 and 10 show the results of equation 6 using the alternative measure of slack for credit limits and balances, respectively.

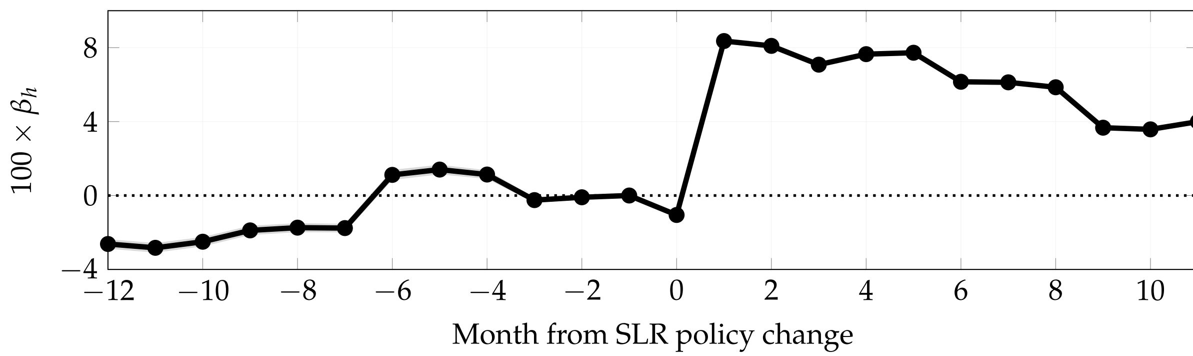

Figure 9: Effect of policy on credit limit using $\widetilde{\text{slack}}$ and consumer plus month fixed effects. All estimates are relative to Q2 2020. Sources: FFIEC 101, Equifax Analytic Dataset, Authors' analysis.

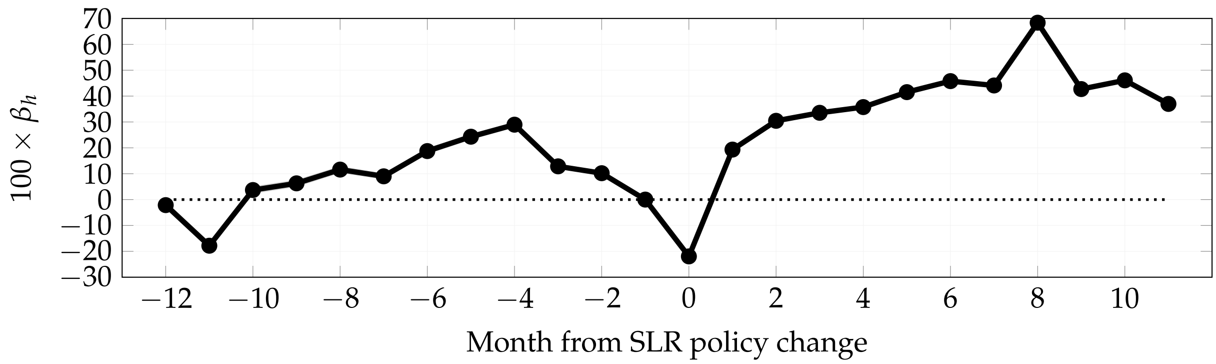

Figure 10: Effect of policy on balances using $\widetilde{\text{slack}}$ and consumer plus month fixed effects. All estimates are relative to Q2 2020. Sources: FFIEC 101, Equifax Analytic Dataset, Authors' analysis.

B Model solution

B.1 Steady state

We consider a symmetric steady state in which all islands have identical fundamentals (i.e. $\underline{a}_t^j$) and in which there are no liquidity shocks. Consequently, all islands are identical and prices are constant across islands. Below are the equilibrium conditions for each of the model's agents. Steady state variables are denoted without a time subscript.

Consumers. The FO and envelope conditions to the consumer's problem are

a_t:

$$u'(c_t) = \beta \mathbb{E}\left[V_1(a_t, z_{t+1})\right]$$

a_{t-1}:

$$V_1(a_{t-1}, z_t) = u'(c_t)(1 + r_t^B)\mathbb{I}(a_{t-1} < 0) + u'(c_t)(1 + r_t^S)\mathbb{I}(a_{t-1} \geq 0)$$

Putting the two together gives the Euler equation, which we write separately for savers and borrowers

$$u'(c_t) = \begin{cases} \beta \mathbb{E}\left[u'(c_{t+1}(1 + r_{t+1}^B)\right] & \text{if } \underline{a}_t^j \leq a_t < 0 \\ \beta \mathbb{E}\left[u'(c_{t+1}(1 + r_{t+1}^S)\right] & \text{if } a_t \geq 0 \end{cases} \tag{16}$$

Government. The government uses tax revenue to pay for interest on its debt and for government consumption

$$rT + G = \tau w \tag{17}$$

Firms. Labor N is the sum of all efficiency units of labor supplied by consumers, namely

$$N \;=\; \int_j \int_i z_i^j \, di \, dj = 1 \tag{18}$$

The wage rate equals the marginal product of labor

$$\begin{aligned} w &= \alpha Z N^{\alpha - 1} \\ &\quad \text{assuming aggregate productivity in steady state is } Z = 1 \\ \Rightarrow w &= \alpha \end{aligned} \tag{19}$$

Bankers. The banker's Lagrangean is

$$\max_{B_t, S_t, T_t} \sum_{t=0}^{\infty} \beta_B^t \left[u\left(S_t + (1 + r_t^B)B_{t-1} + (1 + r_t)T_{t-1} - (1 + r_t^S)S_{t-1} - B_t - T_t\right) + \eta_t \left((1 - \zeta)(B_t^j + T_t^j) - S_t^j\right)\right]$$

The resulting optimality conditions are

B_t:

$$\begin{aligned} & -\beta_B^t u'\left(div_t\right) + \beta_B^{t+1} u'\left(div_{t+1}\right)\left(1 + r_{t+1}^B\right) + \beta_B^t \eta_t (1 - \zeta) = 0 \\ \Rightarrow \quad & \beta_B \frac{u'(div_{t+1})}{u'(div_t)}(1 + r_{t+1}^B) = 1 - \frac{\eta_t}{u'(div_t)}(1 - \zeta) \end{aligned}$$

T_t:

$$\beta_B \frac{u'(div_{t+1})}{u'(div_t)}(1+r_{t+1}) = 1 - \frac{\eta_t}{u'(div_t)}(1-\zeta)$$

S_t:

$$\beta_B \frac{u'(div_{t+1})}{u'(div_t)}(1+r^S_{t+1}) = 1 - \frac{\eta_t}{u'(div_t)}$$

In steady state this system simplifies to

$$\begin{aligned}
\beta_B(1+r^B) &= 1 - \frac{\eta}{u'(div)}(1-\zeta) \\
\beta_B(1+r) &= 1 - \frac{\eta}{u'(div)}(1-\zeta) \\
\beta_B(1+r^S) &= 1 - \frac{\eta}{u'(div)}
\end{aligned}$$

The first two conditions imply that the interest on loans and on treasuries is the same, $r^B = r$. Comparing the conditions on loans and savings gives

$$\beta_B(r^B - r^S) = \zeta \frac{\eta}{u'(div)} \geq 0$$

If $\zeta = 0$ and banks are not subject to any capital requirement, we get the natural benchmark $r^B_{t+1} = r^S_{t+1}$. But, the tighter the constraint and so the larger ζ, the larger the spread between borrowing and savings rates.

If the constraint binds, we have that $\eta = 0$ and $S = (1-\zeta)(B+T)$. This results in the following optimaility steady state condition

$$(1+r^B) = \frac{\zeta}{\beta_B} + (1-\zeta)(1+r^S) \tag{20}$$

B.2 Walras

To derive the goods market clearing condition, sum consumers' budget constraints over consumers and islands at time t gives

$$\begin{aligned}
\int_i \int_j c^j_{i,t} + a^j_{i,t}\, dj\, di &= \int_i \int_j (1+r^B_t) a^j_{i,t-1} \mathbb{I}\left(a^j_{i,t-1} < 0\right) + (1+r^S_t) a^j_{i,t-1} \mathbb{I}\left(a^j_{i,t-1} \geq 0\right) + (1-\tau_t) w_t z^j_{i,t}\, dj\, di \\
C_t + (-B_t + S_t) &= -(1+r^B_t)B_{t-1} + (1+r^S_t)S_{t-1} + (1-\tau_t)w_t
\end{aligned}$$

Summing bankers' budget constraints over bankers and islands at time t gives

$$\begin{aligned}
\int_j div^j_{i,t} + (1+r^S_t)S^j_{t-1} + B^j_t + T^j_t\, dj &= \int_j S^j_t + (1+r^B_t)B^j_{t-1} + (1+r^B_t)T^j_{t-1}\, dj \\
div_t + (1+r^S_t)S_{t-1} + B_t + T_t &= S_t + (1+r^B_t)(B_{t-1} + T_{t-1})
\end{aligned}$$

Summing the two

$$
\begin{aligned}
C_t + S_t + div_t + T_t + (1+r_t^S)S_{t-1} &= (1+r_t^S)S_{t-1} + (1-\tau_t)w_t + S_t + (1+r_t^B)T_{t-1} \\
\Rightarrow C_t + div_t + T_t &= (1-\tau_t)w_t + (1+r_t^B)T_{t-1} \\
\text{imposing 0 profits on firms} & \\
C_t + div_t + T_t &= -\tau_t w_t + Y_t + (1+r_t^B)T_{t-1} \\
\text{imposing the government budget constraint} & \\
C_t + div_t + \underbrace{T_t + \tau_t w_t - (1+r_t^B)T_{t-1}}_{G_t} &= Y_t \\
\Rightarrow C_t + div_t + G_t &= Y_t
\end{aligned}
$$

which is the expected goods market clearing condition.